

Muon anomalous magnetic moment, $B \rightarrow X_s \gamma$ and dark matter detection in the string models with dilaton domination

^a S. Baek , ^b P. Ko , ^b Hong Seok Lee

^a *Department of Physics, National Taiwan University*

Taipei 10764, Taiwan

^b *Department of Physics, KAIST*

Taejon 305-701, Korea

Abstract

We consider the muon anomalous magnetic moment a_μ in the string models with dilaton domination with two different string scales : the usual GUT scale and the intermediate scale. After imposing the direct search limits on the lightest neutral Higgs and SUSY particle masses and the lightest neutralino LSP, the a_μ^{SUSY} is predicted to be less than 65 (55) $\times 10^{-10}$ for $M_{\text{string}} = 2 \times 10^{16}$ GeV (3×10^{11} GeV). If we further impose the $B \rightarrow X_s \gamma$ branching ratio, the predicted a_μ^{SUSY} becomes lower to 35×10^{-10} for intermediate string scale. The resulting LSP - proton scattering cross section is less than $\sim 10^{-7}$ pb, which is below the sensitivity of the current direct dark matter search experiments, but could be covered by future experiments.

The anomalous magnetic dipole moment (MDM) of a muon, $a_\mu \equiv (g_\mu - 2)/2$, is one of the best measured quantities with clean theoretical understanding. Recently, the Brookhaven E821 announced a new data on a_μ [1]:

$$a_\mu^{\text{exp}} = (11659202 \pm 14 \pm 6) \times 10^{-10}. \quad (1)$$

On the other hand, the SM prediction for this quantity has been calculated through five loops in QED and two loops in the electroweak interactions [2] :

$$a_\mu^{\text{SM}} = (11659159.7 \pm 6.7) \times 10^{-10}. \quad (2)$$

This new BNL result is 2.6σ larger than the SM prediction, and the difference between the two,

$$\delta a_\mu \equiv a_\mu^{\text{exp}} - a_\mu^{\text{SM}} = (43 \pm 16) \times 10^{-10}, \quad (3)$$

could be a signal of new physics beyond the standard model (SM), although the statistical significance has to be improved further and hadronic uncertainties in the vacuum polarization and light - light scattering in the SM prediction should be examined more carefully [3]. There have been many discussions on δa_μ in the context of supersymmetric models [4] [5], in non-supersymmetric models [6], as well as in a model independent way [7].

In this letter, we study the muon anomalous magnetic moment and $B \rightarrow X_s \gamma$ in the string models with dilaton domination scenario. If we imposed only the direct search limits for Higgs and SUSY particles and $B \rightarrow X_s \gamma$, there remains a large parameter space in the $(m_{3/2}, \tan \beta)$. But in most of this parameter region, we find that the $\delta a_\mu \equiv a_\mu^{\text{SUSY}}$ turns out to be small compared to the BNL E821 result. There remains only a limited region that is consistent with both a_μ and other direct and indirect constraints on $(m_{3/2}, \tan \beta)$. We also study the neutralino LSP (χ_1^0) – proton cross section $\sigma_{\chi_1^0 p}$, which is relevant to the direct search for neutralino dark matter search experiments.

Let us briefly discuss the string models with dilaton domination scenario. In the present, the most popular extension of the standard model (SM) is the minimal supersymmetric standard model (MSSM), which is presumably a low energy effective theory of more fundamental theory such as superstring or M theory. In weakly interacting perturbative string models, the SUSY breaking can be parameterized in terms of auxiliary fields of two different kinds of quantities : dilaton superfield S and moduli superfields T_i [8]. In principle, the F terms of all these fields could contribute to SUSY breaking, and the soft terms of the low energy theory will depend on $\langle F_S \rangle$ and $\langle F_{T_i} \rangle$. In this work, we will concentrated on the dilaton domination scenario where only $\langle F_S \rangle$ plays an important role in SUSY breaking for the following reasons.

The dilaton domination scenario is very intriguing in phenomenological senses, since it provides a solid ground for the universality of sfermion masses at the string scale, thereby solving the SUSY flavor problems. On the contrary, the so-called minimal supergravity scenario, although this model is a kind of benchmark in the SUSY phenomenology, has no such universality when one goes beyond the minimal Kähler metric. For example, the quantum supergravity corrections can generate a significant non-universality in the sfermion mass terms [9]. However, there is an unsatisfactory aspect of dilaton domination scenario with $M_{\text{string}} \sim 2 \times 10^{16}$ GeV : the whole parameter space is excluded by charge and color breaking

(CCB) minima [10]. Although one could assume that our universe lives in the metastable state for long time before it decays into a true minima breaking charge and color, it would be nice if this problem could be solved within the particle physics context. The authors of Ref. [11] showed that this is in fact achieved in intermediate scale string models with dilaton domination scenario. When one lowers the string scale to the intermediate scale, the CCB constraints becomes considerably weaker, and the resulting string models have an ample parameter space consistent with the phenomenological constraints from unobserved Higgs and SUSY particles. Thus the intermediate scale string models with dilaton domination scenario were advocated as a phenomenologically attractive scenario providing a natural solution to the SUSY flavor problem within the string theory context.

For long time, the fundamental scale of the string theory was thought to be close to the Planck scale so that their low energy implications were doomed to be irrelevant, except that some string moduli can play an important role in cosmology. However this picture has drastically changed after the so-called second string revolution [12]. The string scale is now thought to be anywhere from the Planck scale (which is too high from the particle physics point of view) down to the electroweak scale (which is a good news for particle physics experiments) [13]. The important ingredient for this is the existence of solitonic objects called D branes on which open string ends can attach [14]. Then SM fields are the excitation modes of open string that can be confined to the $D3$ branes. On the other hand, the gravity is the zero mode of a closed string so that it can propagate in the bulk. This can make the fundamental scale different from the Planck scale. Also the presence of D branes reduce the number of SUSY generators and it helps us construct realistic (MS)SM like 4-dimensional particle physics models.

Recently a class of Type-I string models were constructed by orientifolding Type IIB string models [11]. These new classes of Type-I string models differ from the old weakly coupled string models in two important aspects. First of all, the string scale can be arbitrary in principle, and one can make some physical arguments for choosing a particular string scale. In this context, the authors of Ref. [11] argued that the intermediate string scale is natural in many senses : hidden sector and gravity mediated SUSY breaking scenarios, strong CP problem, neutrino masses in the see-saw mechanism, and gauge coupling unification, etc.. Secondly there appear one more moduli field, the Ramond-Ramond superfields M_i associated with the blowing up of orbifold singularities in orientifold constructions. This new object appears in the Type-I string models with D branes, and is important in $U(1)$ anomaly cancellation and generation of the FI terms as well as string axions as a solution to the strong CP problem [11]. In principle, the F terms of all the fields S, T_i and M_i could contribute to SUSY breaking, and the soft terms of the low energy theory will depend on $\langle F_S \rangle, \langle F_{T_i} \rangle$ and $\langle F_{M_i} \rangle$. The generic forms of the soft terms in Type-I string models were described by Allanach et al. [11]. in Type I string models so that one has to include the anomaly mediation and the loop effects in the Kähler potential. However, these loop effects are not well known yet. Therefore they ignored the effects of nonvanishing $\langle F_{T_i} \rangle$ and $\langle F_{M_i} \rangle$, and concentrated on the dilaton domination scenario where only $\langle F_S \rangle$ plays an important role in SUSY breaking. In this work, we consider only the dilaton domination limit for two different string scales, $M_{string} = 2 \times 10^{16}$ GeV and the intermediate string scale $\sim 10^{11}$ GeV.

Some phenomenological aspects of this class of models with intermediate string scale have begun to be explored. The gauge and Yukawa coupling unifications and Higgs and

SUSY particle spectra were discussed in Ref. [11]. Also it was pointed out that the initial scale has a very interesting implication for dark matter search experiments [15] [16]. The authors of Ref. [15] used the minimal supergravity type boundary conditions for the soft SUSY breaking terms at the intermediate scale :

$$m_0, \quad M_{1/2} = -A,$$

where m_0 and $M_{1/2}$ are the universal scalar and the gaugino mass parameters, and A is the universal trilinear couplings. This model is not the same as the model we consider in this work (see Eq. (4).) If one starts the RG running from the intermediate scale with the above boundary conditions for the soft SUSY breaking parameters, the size of the μ parameter becomes lower and the Higgsino component of the lightest neutralino LSP may increase, depending on the choice of M_0 and $M_{1/2}$. This could enhance the neutralino LSP couplings to Higgs bosons so that the spin independent neutralino - nucleus scattering cross section much larger than the binolike LSP case.

With such phenomenologically interesting aspects as well as theoretical motivations for string models with dilaton domination scenario, it would be worthwhile to study phenomenological aspects of these models in more detail. Now the new BNL data on the a_μ began to probe the electroweak and SUSY loop effects on a_μ . Also it is well known that $B \rightarrow X_s \gamma$ branching ratio puts strong constraint on SUSY models, but this constraint was not considered explicitly in the context of the intermediate scale string models with dilaton dominance scenario. Therefore, we study these two observables within the intermediate scale string models with dilaton domination scenario, in addition to the direct search limits considered in the previous study [11].

Assuming that the cosmological constant vanishes ¹ and R parity is conserved, the soft terms in the dilaton domination scenario are given by [11]

$$M_{1/2} = \sqrt{3} m_{3/2} = -A. \quad (4)$$

Here, $m_{3/2}$ is the gravitino mass parameter which is equal to the universal scalar mass m_0 , and $\tan \beta$ is another free parameter of this model. We have ignored the gauge group dependent loop correction effects in the gaugino mass parameter M_a . Therefore, the soft terms of Type I string models in the dilaton domination scenario are identical to the weakly coupled heterotic string models in the dilaton domination scenario. The only difference of these two models are the scale at which the RG running starts, and this effect was shown to be very important [11] [15].

We vary two input parameters $m_{3/2}$ upto 400 GeV and $\tan \beta$ upto 50, and do the standard renormalization group analysis with the above boundary conditions at some string scales M_{string} . Then the particle spectra and mixings are determined with resulting parameters

¹The recent determination of the cosmological parameters strongly favors the presence of a sizeable dark energy (Ω_Λ) in the Universe. One can apply the formulae in Refs. [8] in order to get soft parameters when the nonvanishing cosmological constant. However its size is too small in the TeV scale region we are considering so that its presence is practically unimportant.

at the electroweak scale. For the string scale M_{string} and gauge coupling unification, we consider the following three possibilities ² :

- P1 : the string scale at $M_{\text{string}} = 2 \times 10^{16}$ GeV with gauge coupling unification
- P2 : the string scale at $M_{\text{string}} = 3 \times 10^{11}$ GeV without gauge coupling unification
- P3 : the string scale at $M_{\text{string}} = 3 \times 10^{11}$ GeV with gauge coupling unification by adding extra leptons : $(3 \times E_R + 2 \times L)$ and their vectorlike partners

The motivation for this intermediate scale is given by Abel *et al.* in Ref. [11] : hidden sector and gravity mediated SUSY breaking scenarios, strong CP problem, neutrino masses in the see-saw mechanism, and gauge coupling unification at this scale by adding vectorlike leptons, etc.. As mentioned before, the whole parameter space of the first case P1 is excluded by CCB constraints [10], but not in the cases of intermediate scale, P2 and P3 [11]. Also, in the case P2, it was shown that the charged LSP constraint imposes $\tan \beta < 28$ so that the bottom-tau Yukawa unification is not possible [11]. On the other hand, if one adds extra vectorlike leptons in order to achieve intermediate scale gauge coupling unification, the charged LSP constraint becomes much milder and the bottom-tau Yukawa unification becomes possible for any values of $\tan \beta$. We also assume radiative electroweak symmetry breaking condition.

We impose the direct search limits on the lightest Higgs mass [17]

$$m_h > 93.5 + 15x + 54.3x^2 - 48.4x^3 - 25.7x^4 + 24.8x^5 - 0.5 \text{ GeV} ,$$

where $x = \sin^2(\beta - \alpha)$ and α is the mixing angle of the CP-even Higgs bosons, as well as on the SUSY particle masses :

$$\begin{aligned} m_{\chi^\pm} &> 84 \text{ GeV} \quad [18] , & m_{\chi_1^0} &> 31 \text{ GeV} \quad [18] , & m_{\tilde{g}} &> 300 \text{ GeV} \quad [19] , \\ m_{\tilde{t}_1} &> 83 \text{ GeV} \quad [20] , & m_{\tilde{\tau}_1} &> 72 \text{ GeV} \quad [21] . \end{aligned}$$

It turns out that the lightest neutral Higgs and the lighter stau mass limits are most severe constraints compared to others. In the most parameter space of our model, we have the decoupling case $m_A^2 \gg m_Z^2$. Therefore, $\sin^2(\beta - \alpha) \simeq 1$ and the interaction of the lightest CP even Higgs boson mass is almost SM-like, so $m_h > 113.5$ GeV is a pretty good approximation in the most parameter space region. We also impose the indirect constraints from a_μ [1] and $B \rightarrow X_s \gamma$ [22] at the 2σ level :

$$11 \times 10^{-10} < a_\mu^{\text{SUSY}} < 75 \times 10^{-10} \quad (5)$$

$$2.18 \times 10^{-4} < B(B \rightarrow X_s \gamma) < 4.10 \times 10^{-4} . \quad (6)$$

We also excluded the region where the LSP is charged. If we relax the assumption that the R parity is conserved, the charged LSP region may not be excluded and the allowed parameter

²We used one loop RG equations for the runnings for gauge and Yukawa couplings so that the gauge coupling unifies at a slightly higher scale than the scale obtained in Ref. [11].

region would be wider. However, in such a case, there would be additional contributions to the a_μ^{SUSY} as well as to the $B \rightarrow X_s \gamma$ branching ratio from R parity violating interactions, which would make the whole analysis quite complicated. With R parity conservation, the LSP will be a good candidate for the cold dark matter, the detection of which are actively pursued now at many places. We will study the neutralino LSP - proton scattering cross section in the allowed parameter space in the string models with dilaton domination with different string scales.

It is well known that the sign of a_μ^{SUSY} is correlated with the sign of μ , and Eq. (3) implies that $\mu > 0$ and relatively large $\tan \beta$ is preferred and SUSY particles cannot be too heavy. On the other hand, the SM explains the $B \rightarrow X_s \gamma$ rate very well so that there cannot be significant new physics contribution to it, if the new physics contribution has the same sign as the SM amplitude. This means that the chargino - stop contributions to $B \rightarrow X_s \gamma$ should interfere destructively with the SM and the charged Higgs contributions in order to satisfy the $B \rightarrow X_s \gamma$ constraint [23], which would lead to interesting consequences in other B decays. In this work, we used the NLO calculations for SM contributions and the LO results for SUSY contributions to $B \rightarrow X_s \gamma$. More complete analysis including the SUSY NLO effects enhanced by large $\tan \beta$ will be discussed in a separate publication [24]. And some care should be exercised when we consider the $B \rightarrow X_s \gamma$ constraint in SUSY models with large $\tan \beta$ region, which is relevant to the BNL data on a_μ^{SUSY} . If $\tan \beta$ is large, then SUSY QCD corrections to the bottom Yukawa couplings can be $\sim O(1)$, and one has to make resummation of such enhanced contributions to $B \rightarrow X_s \gamma$. Such attempts were made recently and it was found that the SUSY contribution to $B \rightarrow X_s \gamma$ for $\mu > 0$ (which is selected by the a_μ^{SUSY}) can be enhanced by more than $\sim 50\%$ for large $\tan \beta \sim 30$ [25]. Therefore some points below the $B \rightarrow X_s \gamma$ lower bound may be within the bound after large $\tan \beta$ terms are appropriately resummed.

In Figs. 1 and 2, we show the allowed regions in the $(m_{3/2}, \tan \beta)$ plane with $\mu > 0$ for the case P1 and the correlation between the a_μ^{SUSY} and $B \rightarrow X_s \gamma$ branching ratio therein, respectively. In this case, the whole region is not compatible with the absence of CCB minima condition, which we ignore for the moment. In Fig. 1, the shaded and the dark regions are excluded by the charged LSP and direct search limits on SUSY and Higgs particles, respectively. It turns out that the lower bounds on the lightest neutral Higgs and the lighter stau masses are the most stringent one. The remaining parameter space is consistent with $B \rightarrow X_s \gamma$ branching ratio which is shown by slanted lines. Also the constant a_μ^{SUSY} contours for $a_\mu^{\text{SUSY}} = (11, 27, 43) \times 10^{-10}$ are shown in the same parameter space.

From Fig. 2, we observe that the a_μ^{SUSY} and $B \rightarrow X_s \gamma$ branching ratio is anticorrelated with each other. However, these two are not inversely proportional to each other. Rather the actual correlation is approximately a parabola. The reason is the following. For large $\tan \beta$,

$$a_\mu^{\text{SUSY}} \sim \mu \tan \beta$$

$$\mathcal{M}(b \rightarrow s\gamma) \sim (\text{SM Amp.}) + (\#) \times \mu \tan \beta,$$

where $\#$ is a number depending on SUSY parameters in the loop integral. Since the branching ratio for $B \rightarrow X_s \gamma$ is obtained by squaring the amplitude, we will have quadratic dependence of the $B \rightarrow X_s \gamma$ branching ratio on a_μ^{SUSY} . Let us note that if we choose $\mu > 0$ in order to explain the BNL data, then $B \rightarrow X_s \gamma$ branching ratio turns out to be in the

relatively lower side. A larger a_μ^{SUSY} would be eventually constrained by the direct search limits on Higgs and SUSY particles (especially the lighter stau) and the $B \rightarrow X_s \gamma$ branching ratio.

Similar plots for the cases P2 and P3 (the intermediate string scale without and with gauge coupling unification) are shown in Figs. 3, 4 and Figs. 5, 6, respectively. In the P2 case, the allowed region becomes significantly reduced compared to the cases P1 or P3 mainly because of the charged LSP constraint. The resulting a_μ^{SUSY} becomes somewhat smaller compared to the case P1, partly because μ parameter gets smaller in the intermediate scale string models, but mainly because the allowed region is too small. a_μ^{SUSY} cannot be larger than 30×10^{-10} in the P2 case. For the case P3 (Figs. 5 and 6), the allowed parameter space becomes significantly larger compared to the case P2. The a_μ^{SUSY} can be as large as 55×10^{-10} , if we ignore $B \rightarrow X_s \gamma$ branching ratio. However, if we impose the $B \rightarrow X_s \gamma$ constraint, the possible a_μ^{SUSY} cannot be larger than 35×10^{-11} . In any case, the larger a_μ tends to prefer the smaller branching ratio for $B \rightarrow X_s \gamma$.

Let us consider the effect of the muon anomalous magnetic moment on the neutralino LSP - proton scattering cross section $\sigma_{\chi_1^0 p}$ [26], which is relevant to the dark matter search experiments. For a given string scale, the universal scalar mass $m_0 (= m_{3/2})$ at the string scale is approximately proportional to $\tan \beta$, when we impose the a_μ^{SUSY} and $B \rightarrow X_s \gamma$ constraint. Therefore, the SUSY masses tend to increase as $\tan \beta$ increases for a fixed M_{string} . On the other hand, for a fixed $\tan \beta$, the smaller $m_{3/2}$ is favored by a_μ data, the SUSY particle masses becomes lighter and the cross section will increase. These behaviors can be seen from Figs. 7, 8 for the case P1. In Fig. 7, we show the constant contours for the cross section $\sigma_{\chi_1^0 p}$ (in unit of pb) in the $(m_{3/2}, \tan \beta)$ plane. The dashed curve in the region allowed by the $B \rightarrow X_s \gamma$ constraint represents the 2σ lower bound to a_μ^{SUSY} , and the upper left part of this dashed curve is consistent with the new BNL data on a_μ . Note that the neutralino LSP - proton scattering cross section is less than the sensitivity of current direct dark matter search experiment (DAMA, CDMS) ($\sim 10^{-6}$ pb) [27], mainly because of the direct search limits on Higgs and SUSY particles as well as the $B \rightarrow X_s \gamma$ branching ratio. Therefore the dark matter search experiment cannot be complementary to the indirect constraint from $B \rightarrow X_s \gamma$ in the string models with dilaton domination with $M_{\text{string}} = 2 \times 10^{16}$ GeV.

In Fig. 8, we show the dependence of the cross section on $\tan \beta$, along with the constant contours for a_μ^{SUSY} in unit of 10^{-10} . The slanted lines represent the points consistent with the $B \rightarrow X_s \gamma$ constraint. The left part is cut by the direct search limit and the right part of the slanted lines are cut by the charged LSP constraints. The lower cut of the slanted region is due to the artificial cut at $m_{3/2} = 400$ GeV. As a_μ^{SUSY} increases, the cross section $\sigma_{\chi_1^0 p}$ also increases, since the scalar mass parameter $m_{3/2}$ decreases. For fixed a_μ^{SUSY} , the cross section is a decreasing function of $\tan \beta$, since $m_{3/2}$ also increases when $\tan \beta$ increases and the combined effects result in the decreasing cross section as a function of $\tan \beta$.

In Figs. 9 and 10, we show the same plots for the case P3. (The case P2 is very similar to the case P3 for the neutralino LSP - proton scattering cross section, except that the allowed parameter region is small, and we do not show the plots separately.) In this case, the cross section increases by a factor of ~ 10 compared to the case P1. This is not because the Higgsino component of the LSP increases like the model considered in Ref. [15]. In our case, the gaugino and the scalar mass parameters are not independent with each other, but they

are tightly correlated via Eq. (4). In fact, the neutralino LSP in our model is still binolike, not Higgsino like (see Fig. 11), even if the μ parameter decreases compared to the case P1. The reason why the cross section increases in the case P3 compared to the case P1 is that the squark mass becomes lower in the P3 case, for the same reason why the μ parameter becomes lower in the intermediate scale string models. Still, the predicted cross section is less than $\sim 10^{-7}$ pb, which is below the current direct dark matter search limit over the allowed parameter space. The reason is that the neutralino in the intermediate scale string models with dilaton domination scenario is mainly binolike, not Higgsino like as in Ref. [15]. Note that the model considered in this work Ref. [15] is not exactly the same as the model we considered. Contrary to the claim made therein, the characters of the neutralino LSP is quite sensitive to the parameters m_0 and $M_{1/2}$, as our discussions demonstrate.

In conclusion, we showed that the parameter space of the intermediate scale Type I string models with dilaton domination scenario are strongly constrained by the recent measurement of the muon anomalous MDM a_μ , and also partly by $B \rightarrow X_s \gamma$ branching ratio with some reservation for large $\tan\beta$. If we impose constraints from direct search limits on Higgs and SUSY particles and $B \rightarrow X_s \gamma$ only, there still remains an ample parameter space in $(m_{3/2}, \tan\beta)$ plane which indicates that the SUSY flavor problem is ameliorated in this model. However a substantial part of this parameter space is ruled out by the lower bound of the new data on the muon anomalous magnetic moment. The resulting a_μ^{SUSY} lies in the relatively low side mainly because of the $B \rightarrow X_s \gamma$ constraint. In P3 case a_μ^{SUSY} is somewhat smaller than P1 case, because the resulting μ parameter becomes smaller. The neutralino LSP – proton scattering cross section is also constrained by the BNL a_μ^{SUSY} data. The parameter region resulting in the small cross section is partly removed by the lower bound on a_μ^{SUSY} . Still, the resulting region is too small to be sensitive to current direct DM search experiments. But in the near future, CDMS at Soudan [28] or CRESST [29] will be able to cover a part of this region with $\sigma_{\chi_1^0 p} \sim 10^{-8}$.

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FIGURES

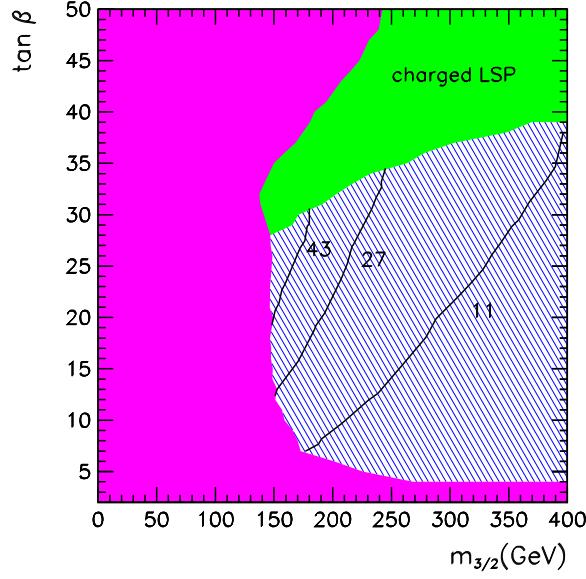


FIG. 1. The parameter space in the $(m_{3/2}, \tan \beta)$ space allowed by the direct search limits and the charged LSP constraint for the case P1. The region allowed by $B(B \rightarrow X_s \gamma)$ is denoted by slanted lines, and the contours for constant a_{μ}^{SUSY} (in unit of 10^{-10}) are shown in different curves. The dark region is excluded by direct search limit.

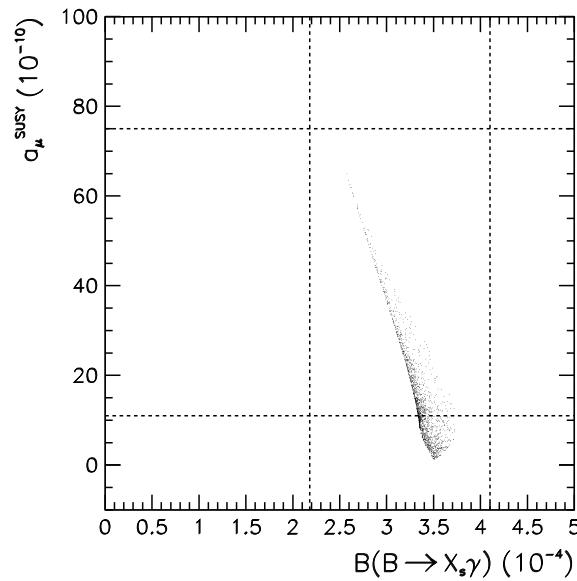


FIG. 2. The correlations between a_{μ}^{SUSY} and $B(B \rightarrow X_s \gamma)$ for the case P1. The vertical dashed lines represent the experimental data for $B(B \rightarrow X_s \gamma)$, and the horizontal lines represent the bound of a_{μ}^{SUSY} to 2σ level.

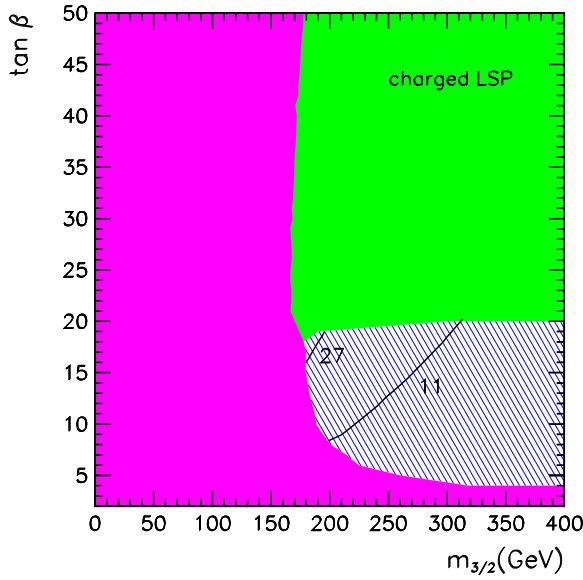


FIG. 3. The same plot as Fig. 1 for the case P2. The CCB minima constraint is imposed, although it is not shown explicitly.

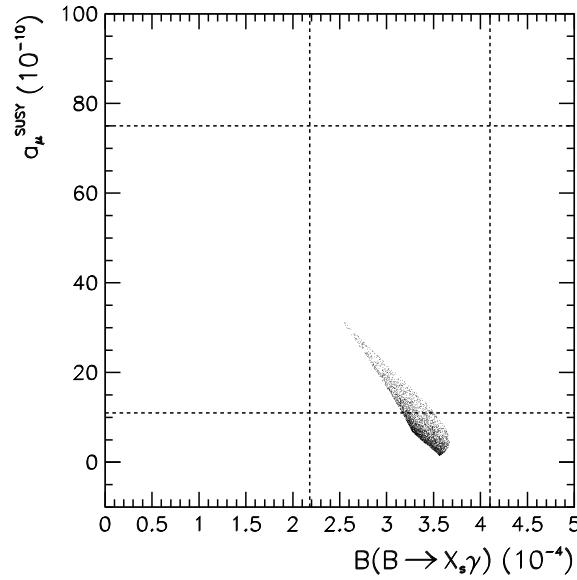


FIG. 4. The same plot as Fig. 2 for the case P2.

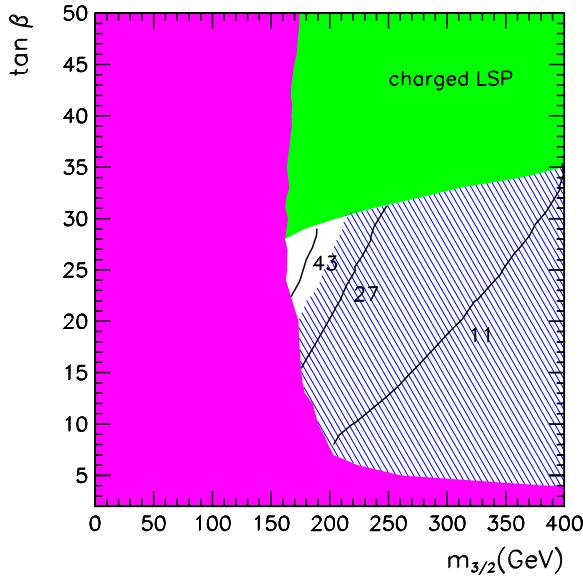


FIG. 5. The same plot as Fig. 1 for the case P3. The CCB minima constraint is imposed, although it is not shown explicitly.

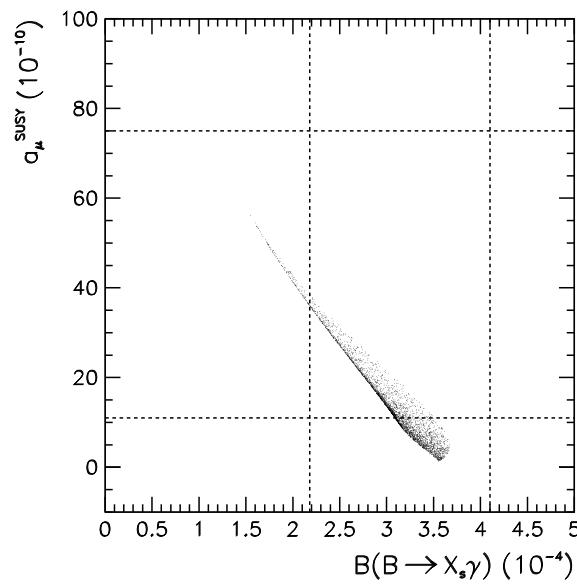


FIG. 6. The same plot as Fig. 2 for the case P3.

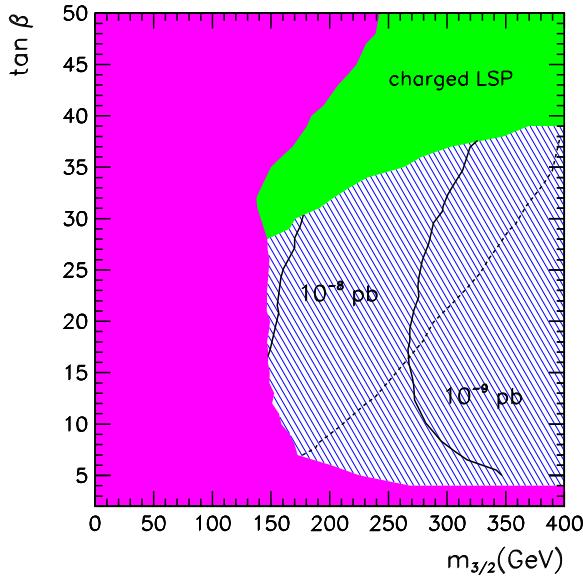


FIG. 7. The contours for the constant neutralino LSP – proton scattering cross section $\sigma_{\chi_1^0 p}$ (in pb) in the $(m_{3/2}, \tan \beta)$ plane for the case P1. The dashed curve corresponds to the 2σ lower bound on a_μ^{SUSY} , the upper left part of which is consistent with the BNL measurement of a_μ .

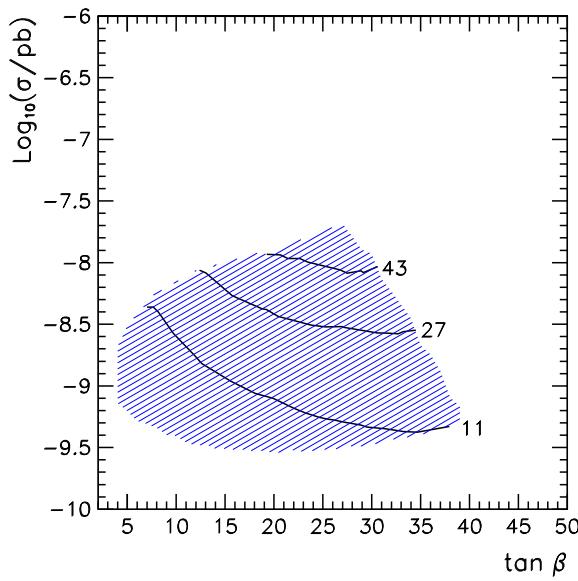


FIG. 8. The neutralino LSP – proton scattering cross section $\sigma_{\chi_1^0 p}$ (in pb) dependence on $\tan \beta$ for the case P1. The region allowed by $B(B \rightarrow X_s \gamma)$ is denoted by slanted lines, and the contours for constant a_μ^{SUSY} are shown in different curves. The dashed horizontal line indicates the lowest sensitivity of DAMA experiment.

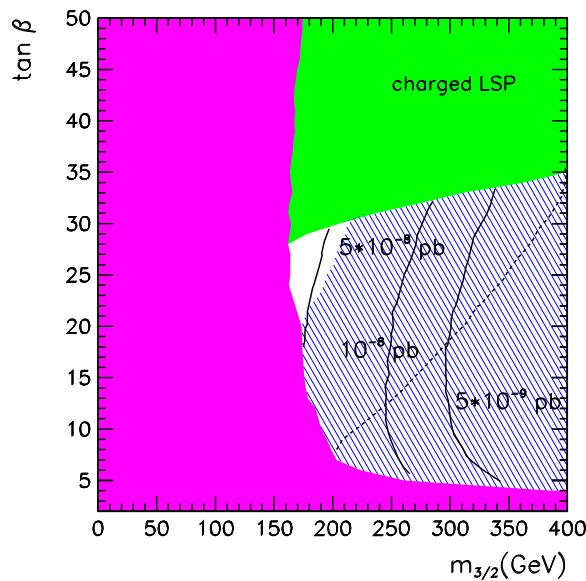


FIG. 9. The same plot as Fig. 5 for the case P3.

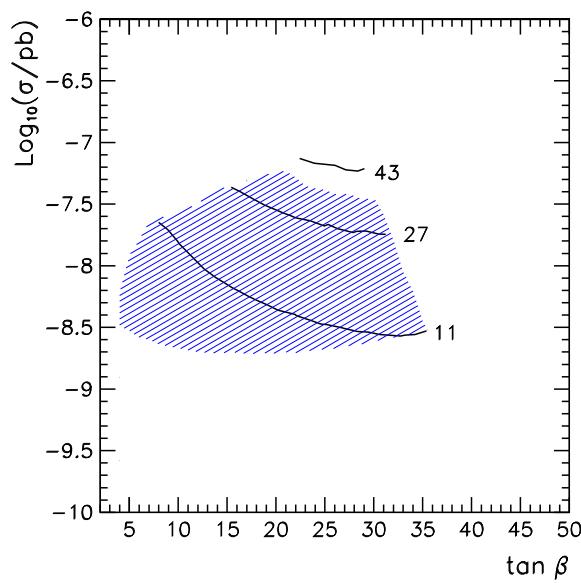


FIG. 10. The same plot as Fig. 6 for the case P3.

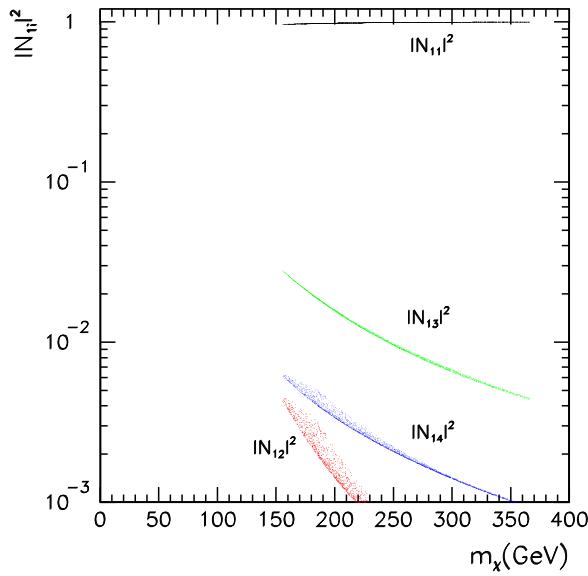


FIG. 11. The bino ($|N_{11}|^2$), wino ($|N_{12}|^2$), higgsino components ($|N_{13}|^2$ and $|N_{14}|^2$) of the lightest LSP as functions of the LSP mass m_χ for the case P3.